

## Ice Records on Grand Traverse Bay

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The dates of formation and loss of ice on lakes and rivers were of interest in past centuries in Europe, Asia, and North America because stable ice cover provided a platform for transportation, fishing, and hunting during the winter months. For these reasons, records of freeze-up and break-up have been kept for several centuries at some bays, rivers, and small inland lakes. These records are also of interest to scientists because the extent and duration of ice cover is a sensitive indicator of climate and climate change. Ice cover also affects biological activity in the waters under the ice. Records of freeze-up and break-up dates for Grand Traverse Bay (which start in 1851) are among the longest available for the Great Lakes. Freeze-up is defined to occur when there is solid ice over West Bay from its southern shoreline to Power Island.

There have been significant changes in the average dates of freeze-up and break-up from 1851 to 1993. The average freeze-up date between 1851 and 1888 is February 7, while between 1889 and 1993 it is February 19, some 12 days later. The average break-up date between 1865 and 1888 is April 14, between 1889 and 1939 it is April 3, some 11 days earlier, and between 1940 and 1993 it is March 25, an additional 8 days earlier. The change in ice event dates prior to 1900 corresponds to the end of a cold period in the northern hemisphere known as the Little Ice Age, which ended during the latter half of the 19th century.

The earlier break-up dates in the 20th century correspond to a general warming that has occurred during the past 100 years. Air temperature has been modeled in terms of freeze-up and break-up dates at Grand Traverse Bay. The model indicates that the early-winter period before about 1890 was approximately  $1.5^{\circ}\text{C}$  cooler than the early-winter period from 1890 to 1993. The mean

temperature of this latter period, however, has remained relatively constant. Changes in break-up dates demonstrate a  $1.0^{\circ}\text{C}$  to  $1.5^{\circ}\text{C}$  increase in late winter and early spring air temperature since 1890. The model implies that the more recent advance in average break-up dates between 1940 and 1993 are associated with an additional warming of approximately  $1.2^{\circ}\text{C}$  in March. Grand Traverse Bay did not freeze up in five of the seven winters after the winter of 1993, the last year included in this study. This lack of freeze-up is matched by the winters from 1987 to 1993, and 1986 to 1992 when the bay also did not freeze up in five out of seven winters. Ice records indeed can be reliable indicators of

climate and climate change. It will be interesting to see if the recent high frequency of ice-free winters on Grand Traverse Bay is sustained or perhaps even exceeded over the next several winters of this new century.

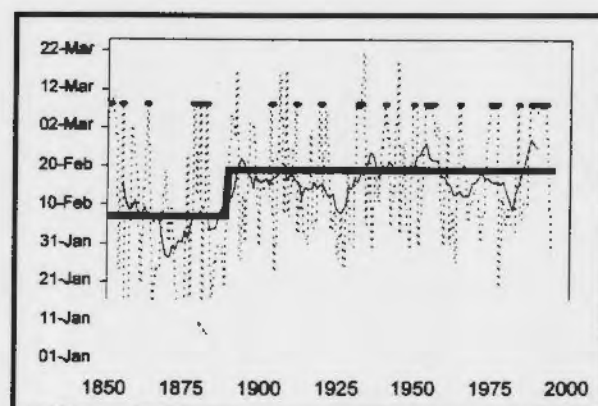


Figure 7: Grand Traverse Bay Freeze-up dates 1851 to 1993 (dashed lines are annual dates, thin solid line is 10-year moving average, heavy solid line is long-term average, solid circles are years when the bay did not freeze up).

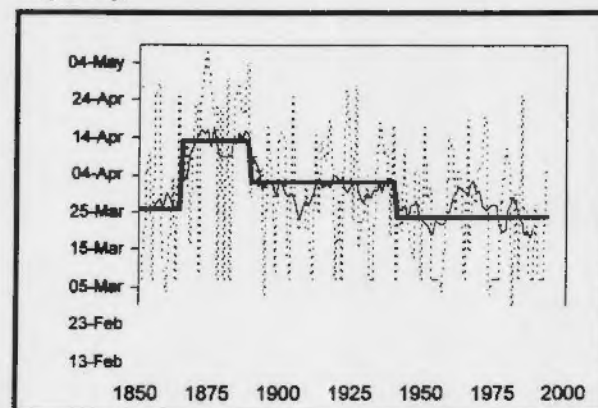


Figure 8: Grand Traverse Bay Break-up dates 1851 to 1993 (dashed lines are annual dates, light solid line is 10-year moving average, heavy straight line is long term average).

# STATE OF THE BAY 2000



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● Indicates that additional information is contained on the enclosed CD ROM.